D. E. Society's

Fergusson College (Autonomous), Pune

Department of Biotechnology

Syllabus

for

T. Y. B. Sc. (Biotechnology)

To be implemented from academic year 2021-22

Fergusson College (Autonomous), Pune

Structure of T. Y. B. Sc. (Biotechnology)

Under CBCS pattern (2019) ***effective from June 2021***

Sem.	Paper No.	Course code	Title	Credits	CE maximum Marks	ESE maximum Marks	Total maximum Marks
V	DSE-1A	BTH3501	Large Scale Manufacturing Processes - I	02	50	50	100
	DSE-1B	BTH3502	Introduction to Diagnostic Techniques	02	50	50	100
	DSE-2A	BTH3503	Genetics and Introduction to Genetic Engineering	02	50	50	100
	DSE-2B	BTH3504	Applications in Medical and Microbial Biotechnology	02	50	50	100
	DSE-3A	BTH3505	Bioanalytical Techniques - I	02	50	50	100
	DSE-3B	BTH3506	Principles in Enzymology	02	50	50	100
	DSE-1	BTH3507	Biotechnology Practical - I	02	50	50	100
	DSE-2	BTH3508	Biotechnology Practical - II	02	50	50	100
	DSE-3	BTH3509	Biotechnology Practical - III	02	50	50	100
	SEC-1*	BTH3511	Biotechnological Skills in Agriculture Industry **OR**	02	50	50	100
	SEC-1*	BTH3512	Phytochemistry				
	SEC-2*	BTH3513	Biosafety and Bioethics **OR**	02	50	50	100
	SEC-2*	BTH3514	Model systems in Biotechnology				
			Total Credits	**22**			**1100**
VI	DSE-4A	BTH3601	Large Scale Manufacturing Processes - II	02	50	50	100
	DSE-4B	BTH3602	Plant Tissue Culture	02	50	50	100
	DSE-5A	BTH3603	Techniques and applications in Genetic Engineering	02	50	50	100
	DSE-5B	BTH3604	Animal Tissue Culture	02	50	50	100
	DSE-6A	BTH3605	Bioanalytical Techniques - II	02	50	50	100
	DSE-6B	BTH3606	Applications in Agriculture and Environmental Biotechnology	02	50	50	100
	DSE-4	BTH3607	Biotechnology Practical - IV	02	50	50	100
	DSE-5	BTH3608	Biotechnology Practical - V	02	50	50	100
	DSE-6	BTH3609	Biotechnology Practical - VI	02	50	50	100
	SEC-3*	BTH3611	Introduction to Bioinformatics **OR**	02	50	50	100
	SEC-3*	BTH3612	Soil Analysis				
	SEC-4*	BTH3613	Survey Methodology **OR**	02	50	50	100
	SEC-4*	BTH3614	Research Proposal Writing and Presentation				
			Total Credits	**22**			**1100**

*** *For SEC courses - CE and ESE exam will be conducted by the department. It will not be conducted centrally*.**

Note:

1. **DSE (Department Specific Elective**) **-** 12 Courses selected by the department. The list provided by UGC CBCS pattern for T. Y. B. Sc. is suggestive in nature and each department has a complete freedom to suggest their own papers under this category based on expertise, specialization, requirements, scope and need.
2. **SEC (Skill Enhancement courses) -** Minimum 4 for T. Y. B. Sc. These courses may be chosen from pool of courses designed to provide value-based and / or Skill-based knowledge and should contain both theory and lab/hands-on-training / field work. The main purpose of these courses is to provide students life-skills in hands on mode so as to increase their employability. The list provided by UGC is suggestive in nature and each department has freedom to suggest their own papers under this category based on expertise, specialization, requirements, scope and need.

BTH 3501: Large Scale Manufacturing Processes - I

Programme	T.Y. B.Sc. (Biotechnology) Semester V	
Course Title	Large Scale Manufacturing Processes - I	
Course Code	BTH3501	
Credits	2	
	Description	Cognitive level (Bloom's Level)
CO1	Define fermentation and. Describe basic bioreactor design, types of Bioreactors and fermentation types.	1
CO2	Analyse growth kinetics in batch, fed batch and continuous cultures and its application in bioprocess	4
CO3	Explain with examples various methods for Screening a production strain and strain improvement techniques.	2,4
CO4	Compare and Contrast different techniques of enzyme immobilization and Cite their Industrial applications	1,5
CO5	Select and construct statistical design for optimization of fermentation media components	6
CO6	Illustrate the principles of Air and Medium Sterilization. and apply them to the designs of Batch and Continuous Sterilization	3

Unit - I	**Fermentation**: Definition, Product types, Historical perspective Lay out of a typical fermentation unit. Types of fermentations; Submerged, Surface, Solid State, Dual, Batch, Continuous, Fed Batch. Microbial growth kinetics for operation of bioreactors; Batch, Continuous and Fed Batch.	8
Unit - II	**Screening:** Definition and Objectives, Primary and Secondary Screening **Strain Improvement**: Objectives, Methods for strain improvement with examples (mutant selection, mutants with altered permeability, auxotrophic mutants, analogue resistant mutants), rDNA technology for strain improvement. Culture collection centers of industrially important microorganisms. Inoculum build up for Industrial fermentations ; Bacteria and Fungi	8
Unit - III	**Bioreactor Design**: Characteristics of an ideal Fermenter, Construction material used, surface treatment of material, Design of a typical Batch Fermenter, Aerator and Agitator - types, Baffles, Seals and valves used, steam traps, additional accessories and peripherals. **Different designs of bioreactors**: Mechanically agitated and non-mechanically agitated, Bubble column, Bubble Cap, Air Lift (internal and external loop), Packed Bed reactor, Fluidized bed reactor, Pressure cycle **Immobilized enzymes:**	8

	Methods of immobilization, Immobilized cell bioreactors and industrial applications	
Unit - IV	**Media components and optimization**: Media used for large scale production **Carbon sources:** Cane and Beet molasses, Malt, Corn, Starch, oils, hydrocarbons, alcohols. **Nitrogen sources**: Corn steep liquor, Soybean meal, peanut meal, distillers soluble, pharmamedia, Buffers, Chelators, Water Precursors, Inhibitors, Inducers, Antifoams- types, mode of action, advantages and disadvantages. **Medium Optimization:** Classical Approach, Plackett and Burman design, Response Surface Methodology (RSM)	7
Unit - V	**Air and Media Sterilization**: Concept of Aseptic Operations and Containment. **Air sterilization**: Principles, Mechanism of capture of particles in air, fixed (absolute) and non-fixed pore (depth) filters, Filter sterilization of air, Theory of depth filter, Validation of air filters. **Media Sterilization**: Principles, Thermal Death time, Decimal reduction time, Del factor, Indicator organism, loss of nutrient quality during sterilization, Equipments used in sterilization; Batch and Continuous, Use of Non sterilized media.	5

References:

1. Stanbury, P. F. and Whittaker, A.and Stephen J Hall; Principles of Fermentation technology; 3rd edition (2016), Butterworth Heinemann, Elsevier
2. Casida, L. E., Industrial Microbiology, 2nd edition (2019), New age International
3. Casida, L. E., Industrial Microbiology, (1986), John Wiley Easterbs.
4. Prescott. S. C. and Dunn, C. G.; Industrial Microbiology, Reed G.; 4th revised edition (2004), CBS.
5. Crueger, W. and Crueger, A.; Biotechnology: A Text Book of Industrial Microbiology, (2017) Medtech
6. E. M. T. El-Mansi, Jens Nielsen, David Mousdale, Ross P. Carlson (2019), Fermentation Microbiology and Biotechnology, 4th Edition,CRC press.
7. Bioreactor Design and Product Yield (1992), BIOTOL series, Butterworths Heinemann.
8. Butterworth, Heinemann, Operational Modes of Bioreactors, (1992), BIOTOL
9. Aiba, S., Humphrey A. L. and Miles, N.F. Biochemical Engineering, 2nd Edition (1973), Academic Press, New York.

eResources:

- https://www.sciencedirect.com/science/article/abs/pii/S0920586120300560
- https://www.intechopen.com/books/growing-and-handling-of-bacterial-cultures/design-and-operation-of-fixed-bed-bioreactors-for-immobilized-bacterial-culture

- https://biologyreader.com/acetic-acid-production.html
- http://medcraveonline.com/JABB/JABB-04-00094.pdf
- https://www.sciencedirect.com/science/article/pii/B9780444639905000050
- https://link.springer.com/article/10.1007/s00449-009-0383-0/figures/1
- https://www.sciencedirect.com/science/article/pii/S2452072116300144
- https://www.researchgate.net/figure/Structure-of-a-modern-fermenter-used-for-submerged-fermentation_fig5_272179875
- https://chemicalengineeringworld.com/types-of-agitators/
- https://www.caframolabsolutions.com/application/dissolving/7-factors-select-impeller/
- https://aerotech.tradeindia.com/variable-pitch-axial-airfoil-3434805.html
- https://ib.bioninja.com.au/standard-level/topic-2-molecular-biology/25-enzymes/enzymes-in-industry.html
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6337536/
- https://www.sciencedirect.com/science/article/pii/S2468823119304560
- http://textbookofbacteriology.net/nutgro_3.html
- https://www.researchgate.net/figure/Classical-steps-in-inoculum-development_fig2_275953938
- http://www.airmaxthai.com/index.php/dop-test/product/view/16/49
- https://www.indiamart.com/proddetail/dop-pao-hepa-filter-integrity-test-services-20942289397.html
- https://www.youtube.com/watch?v=AWTUZijMz4o
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3026452
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4188496
- https://www.hindawi.com/journals/btri/2011/857925
- http://eacharya.inflibnet.ac.in/data-server/eacharya-documents/53e0c6cbe413016f234436f5_INFIEP_17/6/ET/Module-6_(Theory)_Primary_and_Secondary_Screening_of_Industrially_Important_Microbes.pdf

BTH3502: Introduction to Diagnostic Techniques

Programme	T.Y. B.Sc. (Biotechnology) Semester V	
Course Title	Introduction to Diagnostic Techniques	
Course Code	BTH3502	
Credits	2	
	Description	Cognitive level (Bloom's Level)
CO1	Relate and gain proficiency in using modern tools in area of diagnostic microbiology	4
CO2	Outline different methods used to carry out collection and transport of specimens for diagnosis	2,3
CO3	Analyse and understand antimicrobial susceptibility testing and prenatal diagnosis	4
CO4	Review and understand Pathology Lab reports	5
CO5	Discuss and describe histopathology with respect to collection, preparation and processing of the samples and also to interpret the slides.	1,2
CO6	Integrate various applications of diseases like cancer, myocardial infarctions, and infectious diseases	6

Unit-I	**Diagnostic Biology Introduction :** Diagnostic cycle	1
Unit-II	**Diagnostic Microbiology:** Safety and special precautions in clinical microbiology lab, Legislative and regulatory Control Antimicrobial susceptibility testing; Selection of antimicrobial agents, Disc diffusion test, Dilution antimicrobial susceptibility test, E test, Automated commercial systems	4
Unit-III	**Laboratory tests for infectious agents:** Guidelines for the collection, Transport, Processing, Analysis, and Reporting of Cultures from specific specimen sources like respiratory tract, gastrointestinal tract, urinary tract, genital tract , CNS	10
Unit-IV	**Understanding Pathology Lab reports:** Hemogram; Differential count, Total Red Blood cell count, Total White blood cell count, Platelet count. Haemoglobin estimation, Erythrocyte Sedimentation Rate.; Blood groups; matching and cross matching.; Blood coagulation tests; clotting time and prothrombin time.; Estimation of Blood sugar, Liver function tests.; Urine analysis and kidney function tests; Lipid profile**;** Cholesterol, triglyceride, HDLs, LDLs, VLDLs; Hormone Testing; Thyroid function tests.	12
Unit-V	**Prenatal Diagnosis:** Early blood test, triple test**,** fetal development ultrasound, chorionic villus sampling (CVS), Amniocentesis.	3
Unit-VI	**Histopathology:** Introduction to collection, preparation and processing of the samples, interpretation of the slides. Application is various diseases like cancer, myocardical infarctions, and infectious diseases. Immunohistochemistry.	6

References:

1. Robbins, S.L.; Pathological basis of Disease; 9th Edition; (2015); W B Saunders Publishing.
2. Macleod, J.; Davidson's Principles & Practice of Medicine; A textbook for students and doctors' 14th Edition. Churchill Livingstone.
3. Guyton, A.C. and Hall, J.E.; Textbook of Medical Physiology 11th Edition; (2006). W B Saunders Publishing.
4. Hage, D. S. and Carr, J. D.; Analytical Chemistry & Quantitative Analysis; (2010); Prentice Hall.
5. Berg, J.M., Tymoczko, J.L. and Stryer L.; Biochemistry, 5th Edition. W.H. Freeman & Co.
6. Koneman's Color Atlas and Textbook of Diagnostic Microbiology, 7th Edition. Wolters Kluwer, Lippincott Williams & Wilkins.

eResources:

- https://www.pdfdrive.com/konemans-color-atlas-and-textbook-of-diagnostic-microbiology-e184259636.html
- https://www.google.co.in/books/edition/Introduction_to_Diagnostic_Microbiology/zl0PEAAAQBAJ?hl=en&gbpv=1&dq=diagnostic+microbiology&printsec=frontcover

BTH3503: Genetics and Introduction to Genetic Engineering

Programme	T.Y. B.Sc. (Biotechnology) Semester V	
Course Title	Genetics and Introduction to Genetic Engineering	
Course Code	BTH3503	
Credits	2	
	Description	Cognitive level (Bloom's Level)
CO1	Describe the types of plasmids, their structures, properties and discuss the mechanism and role of transposable elements in prokaryotes.	1,2
CO2	Interpret the possible outcomes expected after genome mapping by different techniques.	2
CO3	Compare the mechanisms involved in various phenomena of plant breeding and inheritance. Explain the basics of cytoplasmic inheritance and incompatibility in plants. Compare the mechanisms of DNA transfer in prokaryotes	2,4,5
CO4	Classify restriction enzymes and other DNA modifying enzymes and describe their properties, mode of action and applications.	2,3
CO5	Compare vectors, their design, working and use for DNA modification and describe the methods of vector delivery into hosts for manipulation.	1,4
CO6	Differentiate between prokaryotic and eukaryotic hosts used for Genetic Engineering and specify their importance.	2,6

Unit - I	**Microbial Genetics:** **Bacterial plasmids:** Types; F, R, Col, broad host range and other plasmids, structure, properties and significance **Transposable elements:** Characteristics, transposable elements in prokaryotes (insertion sequences, Transposons) and eukaryotes (yeast Ty elements, Ac/Ds elements in maize, Copia and P elements in Drosophila, Alu sequences in humans), mechanisms of transposition, excision of transposons. **DNA transfer mechanisms:** **Bacterial Conjugation -** F factor, mechanism of conjugation, Hfr strain and its transfer, recombination in recipient cells, F prime, sexduction **Bacterial transformation -** Discovery, detection of transformation, concept of transforming principle, Competence, DNA Uptake. **Transduction -** virulent and temperate phages, lytic and lysogenic life cycles, Molecular basis of decision between lytic and lysogenic cycles in lambda phage, Mechanism of generalised and specialised transduction, abortive transduction, co-transduction and linkage **Gene mapping: Introduction**	12
Unit -II	**Plant Genetics:** Genetics of plant breeding - Genetic basis and mechanisms of pre- and post-zygotic incompatibility; Genetics of androgenic plants; Cytoplasmic inheritance. Genetics of Somaclonal variations	09
Unit -III	**Genetic Engineering - Introduction:** What is genetic engineering? Laying the foundations	02

Unit -IV	**Tools of Recombinant DNA Technology:** Restriction enzymes; Types, properties and application of REs. Other DNA modifying enzymes; ligases, polymerases, alkaline phosphatase, reverse transcriptase, polynucleotide kinase, terminal transferase. PCR and RT-PCR	07
Unit -V	**Host cells and vectors:** Host cell types; Prokaryotic / Eukaryotic Vectors; Significance of vectors in RDT and their designing. Types and properties of vectors; plasmid vectors, bacteriophages, artificial chromosomes.	06

References:

1. Watson, J., Baker, T., Bell, S., Gann, A., Levine, M. and Lodwick, R.; *Molecular Biology of the Gene*, 6thed, Pearson Education, Inc. and Dorling Kindersley Publishing, USA, 2008
2. Glick, B. R., Pasternak, J. J. and Patten C. L.; *Molecular Biotechnology*, 4thed, ASM press, USA, 2010.
3. Primrose, S. and Twyman, R.; *Principles of gene manipulation and genomics*, 7thed, Blackwell Publishing, USA, 2006.
4. Sambrook, J., Fritsch, E., and Maniatis T.; *Molecular cloning; a laboratory manual*, 2nd ed, Cold Spring Harbor Laboratory Press, USA, 1989.
5. Freifelder D.; *Microbial Genetics*, 2nd ed, Narosa book distributors Pvt. Ltd., New Delhi 2009.
6. Stanier, R. Y., Adelberg, E. A. and Ingraham, J. L.; *General Microbiology*; 5thed, Macmillan Press Ltd, 1987
7. Snustad, Simmons, *Principles of genetics*, 6th ed, John Wiley & Sons, Inc.2011
8. Williams, E. G., Clark, A. E. and Bruce Knox R.; *Genetic control of self-incompatibility and reproductive development in flowering plants*, Kluwer Academic Publ., Netherlands, 1994
9. Acquaah, G.*; Principles of plant genetics and breeding*, 2nded, Wiley Blackwell, U.K, 2012.
10. Singh, B. D.; *Plant breeding; principles and methods*, 11thed, Kalyani Publisher, India, 2009
11. Hartl, D. L., Jones, E. W., *Genetics- Analysis of genes and genomes*, 8th ed, Jones and Bartlett learning, 2011

e Resources:

- http://www.bioinformatics.nl/molbi/SimpleCloningLab/electrophoresis.htm
- https://www.ndsu.edu/pubweb/~mcclean/plsc431/transelem/trans4.htm
- https://www.youtube.com/watch?v=eSD_tbjfSlA
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4318427/
- http://plantbreeding.coe.uga.edu/index.php?title=4._Plant_Reproductive_Systems
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3507026/

BTH3504: Applications in Medical and Microbial Biotechnology

Programme	T.Y. B.Sc. (Biotechnology) Semester V	
Course Title	Applications in Medical and Microbial Biotechnology	
Course Code	BTH3504	
Credits	2	
	Description	Cognitive level (Bloom's Level)
CO1	Outline and apply importance of biotechnology and its applications in different spheres of life sciences	1,3
CO2	Analyse the contribution of Microbial biotechnology as a major participant in global industry.	4
CO3	Integrate and articulate how application of microbial-biotechnological principles has achieved breakthroughs in both research and industrial production.	2,4
CO4	Design methods and apply the role of medical biotechnology in disease diagnosis, prevention and treatment.	6
CO5	Describe and evaluate Role of Biotechnology in healthcare- disease diagnosis, prevention and treatment	1,5
CO6	Devise application for Personalised Medicine	6

Unit-I	Introduction to Applications of biotechnology in different spheres of life sciences	2
Unit-II	**Microbial Biotechnology:** Microbial enhanced oil recovery (MEOR), microbial leaching, biosurfactants, biofertilizers, biopolymers, biopesticides, biosensors and biochips, bioluminescence, pre-and probiotics	17
Unit-III	**Medical Biotechnology:** Role of Biotechnology in healthcare- disease diagnosis, prevention and treatment; Development of diagnostics (including molecular diagnostics), vaccines- principle and practice; and therapy; Recombinant products for human health; personalized medicine and its application; monoclonal antibodies as therapeutics; mass-production of insulin, hormones, and other drugs	17

References:

1. Sasson, A.; Medical biotechnology; Achievements, Prospects and Perceptions, United Nations University Press, NY, USA, 2005
2. Glick, B., Delovitch, T. and Patten, C.; Medical Biotechnology ASM Press, NW, Washington DC, USA, 2014
3. Pongracz, J. and Keen, M.; Medical Biotechnology E-Book, Elsevier Health Sciences, Amsterdam, Netherlands , 2008
4. Glazer, A. and Nikaido, H.; Microbial biotechnology; fundamentals of applied microbiology, Cambridge University Press, Cambridge, England , 2007
5. Farshad, H. and Chen, H.; Microbial Biotechnology; Progress and Trends , CRC Press, NW, Boca Raton, FL , 2014

6. Arora, R.; Microbial biotechnology; energy and environment, CABI, Wallingford, Oxfordshire, USA , 2012

e-Resources

- www.crec.ifas.ufl.edu/academics/faculty/reyes/PDF/BiosensorsEAFBE.pdf
- http://nanohub.org/resources/2261/download/
- http://www.ceb.utk.edu/bioprimer.pdf
- https://www.ijser.org/researchpaper/A-REVIEW-OF-MICROBIAL-ENHANCED-OIL-RECOVERY.pdf
- https://cdn.intechopen.com/pdfs/37038/InTech-Microbial_enhanced_oil_recovery.pdf

BTH3505: Bioanalytical Techniques- I

Programme	T.Y. B.Sc. (Biotechnology) Semester V	
Course Title	Bioanalytical Techniques-I	
Course Code	BTH3505	
Credits	2	
	Description	Cognitive level (Bloom's Level)
CO1	Describe basic features and components of different centrifuges, microscopes, spectrometers, and chromatographic system.	1
CO2	State the physicochemical properties and principles used to achieve separation of compounds	2
CO3	Illustrate experimental details of these techniques	3
CO4	Compare and contrast the advantages and limitations of these techniques	4
CO5	Analyze and interpret the results	5
CO6	Design a quality assurance scheme in terms of standard operating procedure for maintenance of instruments	6

Unit-I	Centrifugation: relative centrifugal force, principle of sedimentation, types of centrifuges, preparative and analytical centrifugation	4
Unit-II	Electrophoresis: Principles and applications of Isoelectric focusing gels (IEF), Two-dimensional polyacrylamide gel electrophoresis (2-D PAGE), Pulsed-field gel electrophoresis (PFGE), Capillary electrophoresis	8
Unit-III	Microscopy: Light microscope; simple, compound and stereo microscope. Electron microscope; Transmission Electron Microscope (TEM), Scanning Electron Microscope (SEM)	8
Unit-IV	Chromatography: Gas chromatography (GC) and High Performance Liquid Chromatography (HPLC); principle, mobile and stationary phases, instrumentation, columns, detectors, applications	8
Unit-V	Spectroscopy: Theory, instrumentation and applications of UV-Vis, spectrofluorimetry, circular dichroism spectroscopy and Luminometry	8

References:

1. Wilson, K., Walker, J.; *Principles and Techniques of Biochemistry and Molecular Biology*, 7th ed, Cambridge University Press, UK, 2010.
2. Boyer, R..; *Modern experimental biochemistry*, 3rd ed, Benjamin Cummings, USA, 2000.
3. Upadhyay, A., Upadhyay, K., Nath, N.; *Biophysical Chemistry (Principles and Techniques)*, 4th ed, Himalaya Publishing House, India, 2016.

e Resources:

- https://www.olympus-lifescience.com/en/microscope-resource

- https://edu.rsc.org/resources

BTH3506: Principles in Enzymology

Programme	T.Y. B.Sc. (Biotechnology) Semester V	
Course Title	Principles in Enzymology	
Course Code	BTH3506	
Credits	2	
	Description	Cognitive level (Bloom's Level)
CO1	Define key terms in enzymology	1
CO2	Describe and compare cooperative binding models	2
CO3	Illustrate enzyme assay conditions	3
CO4	Justify choice of method for studying enzyme assay	4
CO5	Organize enzyme kinetics data and determine kinetic constants	5
CO6	Design enzyme purification scheme	6

Unit-I	Enzymes: basic concepts, standard free-energy change and its relation to equilibrium constant, formation of enzyme-substrate complex, Michaelis-Menten model for kinetic properties, Importance of Km and Vm, Velocity versus substrate concentration curves, methods of plotting enzyme kinetics data; Lineweaver-Burk plot, Hanes-Woolf plot, Woolf-Augustinsson-Hofstee plot, Eadie-Scatchard plot	10
Unit-II	Enzyme assays: initial velocity as a function of total enzyme concentration, enzyme units, specific activity, turnover number, how to check efficiency of each step of enzyme purification. Experimental methods to study enzyme assay; optical spectroscopy, Fluorescence measurements, Radioisotopic measurements.	14
Unit-III	Allosteric enzymes with special reference to aspartate transcarbomylase, Cooperativity in enzyme catalysis: Positive and negative cooperativity, models of allosteric behaviour; Sequential interaction model (Koshland), Concerted transition model (MWC).	12

References:

1. Price, N., Stevens L.; *Fundamentals of Enzymology*, 3rded, Oxford University Press, UK, 1999.
2. Lehninger, A., Nelson D., Cox M.; *Principles of Biochemistry*, 5thed, W.H. Freeman and Company, USA, 2008.
3. Berg, J., Stryer, L; *Biochemistry*; 7thed, W.H. Freeman and Company, USA, 2006.

4. Palmer, T., Bonner, P.; *Enzymes; Biochemistry, Biotechnology and Clinical Chemistry,* 2nd ed, Woodhead Publishing Ltd., UK, 2014.
5. Voet, D., Voet, J.; *Biochemistry,* 4th ed, John Wiley and Sons, USA, 2012.
6. Segel, I.; *Biochemical calculations,* 2nd ed, Wiley publications, USA, 2010.
7. Plummer, D.; *An introduction to practical Biochemistry,* 3rd ed, Tata McGraw Hill, India, 2004.

e Resources:

- https://www.brenda-enzymes.org/
- E book: Copeland, R; *Enzymes: A practical introduction to structure, mechanism and data analysis,* 2nd ed , John Wiley and Sons, , USA, 2000.

BTH3507: Biotechnology Practical- I (LSMP I + Diagnostic Techniques)

Programme	T.Y. B.Sc. (Biotechnology) Semester V	
Course Title	Biotechnology Practical-I (LSMP I + Diagnostic Techniques)	
Course Code	BTH3507	
Credits	2	
	Description	Cognitive level (Bloom's Level)
CO1	Demonstrate growth curve studies and calculate generation time of bacteria / yeasts Calculate D value of bacteria	3
CO2	Illustrate: Enrichment and primary screening of an enzyme/antibiotic Whole cell immobilization technique	3
CO3	Cite various parts and explain working of a bench top fermenter	4
CO4	Design different transport media used in diagnosis of diseases	6
CO5	Analyse and test different methods used for Antimicrobial susceptibility testing	4,5

Sr. No.	**List of Practicals**	**Practical (12P)**
1.	Study of Growth curve and Generation time of Bacteria /yeast.	2
2.	Primary screening of a production strain (antibiotic or enzyme)	2
3.	Calculation of D value of the given organism	1
4.	Immobilization of whole yeast cells / enzyme by suitable method and determination of stability of immobilized enzyme.	2
5.	Study of different parts of a Laboratory scale Bioreactor	1
6.	Preparation of Transport Media (Viral/Bacterial)	1
7.	E-test/Disc Diffusion test	2
8.	Visit to a Diagnostics lab and report writing	1
CO6	Identify and compile the process of diagnosis	1,2

BTH3508: Biotechnology Practical- II

(Genetic Engineering + Medical and Microbial Biotechnology)

Programme	T.Y. B.Sc. (Biotechnology) Semester V	
Course Title	Biotechnology Practical-II (Genetic Engineering + Medical and Microbial Biotechnology)	
Course Code	BTH3508	
Credits	2	
	Description	Cognitive level (Bloom's Level)
CO1	Demonstrate the steps for Genomic DNA isolation from Animal source and design the experimental setup and requirements for isolation from any other source.	3, 6
CO2	Define and describe Plasmid DNA and its applications in genetic engineering. Demonstrate and Standardize the Plasmid isolation protocol by alkaline lysis. Outline and interpret the results of plasmid isolation and select the recombinants	1, 2, 3, 5
CO3	Outline, recall and carry out preparation of competent cells and Design and demonstrate procedure for transformation of E. coli. Outline and interpret the results and select the recombinants.	1, 3, 6
CO4	Describe the principle and Analyze the outcome for auxotrophic/ antibiotic resistant mutants by replica plate technique.	1, 4
CO5	Design a protocol to isolate Bioluminescent bacteria and to study its application	6
CO6	Carry out isolation of Biosurfactant / Bioploymer organism and test its potential.	3

Sr. No.	List of Practicals	Practical (12P)
1.	Genomic (Animal) DNA isolation	2
2.	Plasmid DNA isolation	2
3.	Preparation of competent Cells and Transformation of *E. coli* and selection of recombinants	2
4.	Isolation of mutants by replica plate technique	2
5.	Isolation of bioluminescent bacteria and assessment of toxicity of metals in water	2
6.	Isolation of Biosurfactant /Biopolymer producing organism and to check biosurfactant/Biopolymer activity	2

BTH3509: Biotechnology Practical-III (Bioanalytical Techniques I + Enzymology)

Programme	T.Y. B.Sc. (Biotechnology) Semester V	
Course Title	Biotechnology Practical-III (Bioanalytical Techniques I + Enzymology)	
Course Code	BTH3509	
Credits	2	
	Description	Cognitive level (Bloom's Level)
CO1	Apply centrifugal techniques to obtain sub-cellular fractions of goat liver cells	2
CO2	Perform and analyze amino acid separation by paper chromatography/TLC	4, 6
CO3	Validate Beer-Lambert's law and determine the molar extinction coefficient of NADH	5
CO4	Describe the following techniques through electron/ photomicrographs: fluorescence microscopy, positive staining, negative staining, freeze fracture, freeze etching	1
CO5	Perform partial purification and assay of enzyme	6
CO6	Perform assay for the partially purified enzyme, Calculate kinetic parameters such as Km, Vmax, Kcat	3, 6

Sr. No.	List of Practicals	Practical (12P)
1.	Preparation of the sub-cellular fractions of goat liver cells	2
2.	Separation of amino acids by paper chromatography/TLC	1
3.	Checking the validity of Beer-Lambert's law and determine the molar extinction coefficient of NADH.	1
4.	Study the following techniques through electron/ photomicrographs: fluorescence microscopy, positive staining, negative staining, freeze fracture, freeze etching	2
5.	Partial purification of an enzyme from any natural resource	2
6.	Perform assay for the partially purified enzyme	2
7.	Calculation of kinetic parameters such as Km, Vmax, Kcat	2

References:

1. Wilson, K., Walker, J.; *Principles and Techniques of Biochemistry and Molecular Biology*, 7th ed, Cambridge University Press, UK, 2010.
2. Boyer, R..; *Modern experimental biochemistry*, 3rd ed, Benjamin Cummings, USA, 2000.
3. Upadhyay, A., Upadhyay, K., Nath, N.; *Biophysical Chemistry (Principles and Techniques)*, 4th ed, Himalaya Publishing House, India, 2016.

e Resources:

- https://www.olympus-lifescience.com/en/microscope-resource
- https://edu.rsc.org/resources

BTH 3511: Biotechnological Skills in Agriculture Industry

Programme	T. Y. B. Sc. (Biotechnology) Semester V	
Course Title	Biotechnological Skills in Agriculture Industry	
Course Code	BTH3511	
Credits	2	
	Description	Cognitive level (Bloom's Level)
CO1	Define and Describe types of Biofertilizers and Mushrooms, their advantages and limitations	1
CO2	Demonstrate the techniques involved in isolation of organisms from soil with biofertilizer potential	3
CO3	Formulate and prepare carrier bases biofertilizers and Demonstrate the field application and quality control techniques	3,6
CO4	Discuss development of fruiting bodies and Demonstrate the techniques of cultivation of Mushrooms	2,3
CO5	Analyse the nutritive value of Mushrooms and discuss the beneficial effect of mushrooms on soil	2,4
CO6	Standardize suitable methods of mushroom cultivation.	5

Unit-I	**Biofertilizers:** Introduction to Bio fertilizers, Advantages of Bio fertilizers over chemical fertilizers,	2
Unit-II	Types of Bio fertilizers Isolation of potential organism from soil, Preparation of carrier-based bio fertilizers, Quality control test for bio fertilizers, Field application techniques,	12
Unit-III	**Mushroom Cultivation** Introduction and Significance of Mushrooms	2
Unit-IV	***Pleurotus* spp. (Oyster mushroom) :** Morphology of *Pleurotus* **Method of Cultivation:** Preparation of spawn Selection and preparation of substrate Inoculation, Incubation, Harvesting of fruiting bodies. Food value and uses of mushrooms.	12
Unit-V	Visit to bio fertilizer producing/ Mushroom Cultivation facility	2

References:

1. Joy Sarkar Krishnendu Acharya, Anirban Roy. *Mushroom Cultivation Technology* Paperback – 1 January 2020
2. S. Biswas , M. Datta , S. V. Ngachan. *Mushrooms: A Manual for Cultivation* , PHI Learning
3. S. R. Mishra. *Techniques of Mushroom Cultivation* (English, Hardcover)
4. 2020 NIIR BOARD *Handbook On Mushroom Cultivation and Processing (With dehydration, preservation and canning)* Paperback – 1 January 2020

5. (Board Eiri) *Hand Book of Mushroom Cultivation, Processing and Packagin* Publisher: Engineers India Research Institute
6. B C, Suman, V P Sharma Mushroom Cultivation in India Hardcover – 1 August 2007 Daya Publishing House
7. Krishnendu Acharya, Surjit Sen , Manjula Rai ,Biofertilizers and Biopesticides, (2019), Techno World
8. Giri, B., Prasad, R., Wu, Q.-S., Varma, A. (Eds.) ,(2019, Biofertilizers for Sustainable Agriculture and Environment ,) ,Springer International Publishing
9. Mahendra Rai (2008),Handbook of Microbial Biofertilizers, CRC press

BTH 3512: Phytochemistry

Programme	T.Y. B.Sc. (Biotechnology) Semester V	
Course Title	Phytochemistry	
Course Code	BTH3512	
Credits	2	
	Description	Cognitive level (Bloom's Level)
CO1	Describe the use of medicinal plant in drug discovery process	1
CO2	Discuss various methods of extraction, isolation and characterization of natural products.	3
CO3	Classify primary and secondary metabolites and various therapeutic classes.	5
CO4	Carryout the identification tests for general classes, marker specific tests of phytochemicals	6
CO5	Explain the computational methods for phytochemical analysis.	2
CO6	Generate the lead library for phytoconstituents and evaluate the synthesis feasibility of identified lead molecules.	4

Unit-I	Conceptual idea on medicinal and economically important medicinal and aromatic plants (MAPs). Process of collection, cultivation and trade of MAPs. Relationship between conservation sites and richness of MAPs. Commercial MAPs of India. Promoting medicinal plants cultivation as a tool for biodiversity conservation. Yield assessment and cost-benefit analysis. Role of National Medicinal Plant Board (NMPB) in Promotion of MAPs. Marketing of Medicinal Plants: Challenges and Strategies.	4
Unit-II	Methods of extraction, isolation and characterization of natural products. Various separation techniques used for isolation of natural products. Biosynthetic pathways. Primary metabolites, their examples. Secondary metabolites, various classes of secondary metabolites (e.g. Alkaloids, glycosides, tannins, lignans, saponins, lipids, flavonoids, coumarins etc.). Important therapeutic classes: anti-diabetics, hepatoprotectives, immunomodulators, nutraceuticals, natural products for gynecological disorders, anti-cancer, anti-viral (mainly anti-HIV), adaptogens etc.	10
Unit-III	Phytochemistry of some plants like Neem, Turmeric, Withaniasomnifera, Andrographis paniculata, Ginger, Brahmi, Terminalia Arjuna : General chemical class and identification tests, specific tests for markers, special reference to alkaloids (nimbin, nimbolide etc.), special reference to bitters (bacosides), special reference to phenols (curcuminoids),special reference to steroids (withanolides), special reference to bitters (andrographolides), special reference to phenols (gingerols), special reference to phenols (allicin), , special reference to triterpenes (arjunolic acid)	12

Unit-IV	Computational Phytochemistry: Screening of the Disease target molecules from PDB, Screening of phytochemicals, Scaffold Hopping of major phytoconstituents identified in the study, Virtual Lead Library Enumeration and Screening , Lead Optimization, Prioritization of Lead Molecules, Molecular Docking ,Dynamics and DFT Modelling, Validation of lead molecule, Evaluation of simulation results in Wet Lab	10

References:

1. Cutler, Stephen J.; Cutler, Horace G. *Biologically active natural products: pharmaceuticals*. CRC Press 2000.
2. Newman DJ, Cragg GM Natural products as sources of new drugs over the last 25 years. Journal of Natural Products 70, 461-477, 2007.
3. Dossey, Aaron "Insects and their chemical weaponry: New potential for drug discovery". Natural Product Reports27: 1737–1757, 2010.
4. Dan Bensky, Steven Clavey, Erich Stoger, and Andrew Gamble *Chinese Herbal Medicine:* Materia Medica, 3rd ed. 2004
5. El-Shemy HA, Aboul-Enein AM, Aboul-Enein KM, Fujita K *Willow Leaves' Extracts Contain Anti-Tumor Agents Effective against Three Cell Types.: PLoS ONE.;2: e178*, 2007
6. G Brahmachari et. al., *Natural Products in Drug Discovery: Impacts and Opportunities—An Assessment.*, 2010
7. AJ Giannini, AE Slaby. *Drugs of Abuse. Oradell, NJ, Medical Economics Books*, 1989.
8. Dewick, P. M., *Medicinal Natural Products: A Biosynthetic Approach. United Kingdom: John Wiley & Sons. 335-336,* 2009.
9. Barbier P, Schneider F, *"Syntheses of tetrahydrolipstatin and absolute configuration of tetrahydrolipstatin and lipstatin".* Helvetica Chimica Acta70 (1): 196–202, 1987.
10. Goodman, Jordan; Walsh, Vivien, *The Story of Taxol: Nature and Politics in the Pursuit of an Anti-Cancer Drug*, Cambridge University Press. p. 51, 2001.
11. Kinghorn, A. D., Chin, Y.-W., & Swanson, S. M., *" Discovery of Natural Product Anticancer Agents from Biodiverse".* Curr Opin Drug Discov Devel: 189–196, 2009.
12. Siddiqqui A. A. And Seemi Siddiqui , *Natural Products Chemistry for Sci and Pharmacy Course*. Eds. CBS Publisher, 2012.
13. Praveen Kumar, *Natural Products: Practical Manual* eds. Pharma Books Syndicate, 2009.
14. Miechel Verral, *Downstream processing of Natural Products. A Practical Handbook*, 2011

e Resources:

- https://phytochem.nal.usda.gov/phytochem/search
- https://cb.imsc.res.in/imppat/home
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3867654/
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- https://www.frontiersin.org/articles/10.3389/fpls.2018.01081/full
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- http://faculty.iiitd.ac.in/~bagler/webservers/Phytochemica/searchresults1.php

BTH3513: Biosafety and Bioethics

Programme	T.Y. B.Sc. (Biotechnology) Semester V	
Course Title	Biosafety and Bioethics	
Course Code	BTH3513	
Credits	2	
	Description	Cognitive level (Bloom's Level)
CO1	Discuss the use of ethics and bioethics, human interaction with its environment.	1
CO2	Analyze influence of environment on human performance, bioethical issues, and their solutions. Identify and gain the insights into the regulatory affairs	4
CO3	Explain various processes of biosafety and infrastructure setup according to national and international standards.	2
CO4	Acquire adequate knowledge in the use of genetically modified organisms and its effect on human health.	6
CO5	Describe the biosafety future aspects to address the advancement in the subject.	5
CO6	Discuss the need of the establishment of bioethics committee at institute level	3

Unit-I	**Concept of Bioethics and Biosafety in Biotechnology**: Understanding bioethical and biosafety issues related to healthcare, medicine, genetic engineering, food & agriculture etc. through examples and case studies.	10
Unit-II	**Biosafety:** Introduction and Historical Background, Good Lab Practices: Biosafety considerations while dealing with GMOs/ Pathogens, Hazardous compounds. Safety measures of laboratory personnel. Disposal: Medical waste disposal, Radiation safety, Research lab waste disposal. Levels of Biosafety: Identification Risk groups and measures of biocontainment, Biosafety levels and appropriate infrastructure design. Overview of National and Internal standards of Biosafety. Different Regulatory Bodies.	12
Unit-III	**Bioethics:** Introduction and Historical Background, Understanding morality in science, Informed consents, Research misconducts and patenting, Conflict of interest. Environmental ethics, GMOs and synthetic organisms, Advance care planning, Stem cells and cloning, Modern reproduction technologies, Scientific truth telling and withholding information, Overview of Various Ethical committees and governing bodies	12
Unit-IV	**Biosafety and Bioethical future aspects:** issues that need to be addressed considering the advancements in the field	2

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1) Sasson, A.; Biotechnologies and Development, UNESCO Publications.
2) Gimble, M. J.; Academia to Biotechnology, Elsevier Academic Press.
3) Joshi, R.; Biosafety and Bioethics (Ed.) (2006), Isha Books, Delhi.
4) Kuhse, H.; Bioethics: an Anthology. (2006) Malden and Blackwell Publishing.

e Resources:

- Department of Biotechnology, Ministry of Science and Technology, Government of India; Revised guidelines for safety in biotechnology. Available from: http://dbtbiosafety.nic.in/guideline/pdf/guidelines94.pdf.

BTH3514: Model systems in Biotechnology

Programme	T.Y. B.Sc. (Biotechnology) Semester V	
Course Title	Model systems in Biotechnology	
Course Code	BTH3514	
Credits	2	
	Description	Cognitive level (Bloom's Level)
CO1	Define applications of model organisms in biology	1
CO2	Analyze and describe the use of various model systems in research.	1,4
CO3	Explain application of model organisms with examples.	2
CO4	Compare and contrast different types of model organisms and their advantages/disadvantages.	4
CO5	Review and recommend choice of a model organism for a particular research approach.	5
CO6	Illustrate different model systems and justify its use. Design experiments to employ a certain model system successfully.	3,6

Unit-I	Introduction to model organisms, concept, examples and ideal model system.	5
Unit-II	Invertebrate model system: Hydra, C. elegans, Drosophila, Zebrafish	12
Unit-III	Vertebrate Model systems: Xenopus, Chick, Mouse	14
Unit-IV	Plant Model system: Arabidopsis	5
All the model systems explained on the basis of following parameters: Maintenance and culturing, Life cycle, salient features, mutants, parameters making it an ideal model organism		

References:

1) Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., Walter, P.; Molecular Biology of the Cell, 5th Edition (2007), Garland Science, USA.
2) Wolpert, L., Tickle, C., Jessell, T., Lawrence, P., Meyerowitz, E., Robertson, E., Smith, J.; Principles of Development. 4th edition (2011), Oxford University Press, UK
3) Westerfield, M.; The Zebrafish book; A guide for the laboratory use of zebrafish (Danio rerio) 4th edition (2000), University of Oregon Press, Eugene.
4) Hedges, S. B.; The origin and evolution of model organisms. Nat. Rev. Genet.3; 838-849 (2002).
5) Grimmelikhuijzen, C.J.P. and Schaller, H. C.; "Hydra as a model organism for the study of morphogenesis." Trends in Biochemical Sciences 4, 12; 265-267 (1979).
6) Galliot, B.; Hydra, a fruitful model system for 270 years; International Journal of Developmental Biology, 56, 411-423 (2012).
7) Beckingham, K. M., Armstrong, J. D., Texada, M. J., Munjaal, R. and Baker, D. A.; Drosophila melanogaster : The model organism of choice for the complex biology of multi-cellular organisms. Gravitational and Space Research, 18(2) (2007).

e Resources:

- http;//www.zfic.org

BTH 3601: Large Scale Manufacturing Processes -II

Programme	T.Y. B.Sc. (Biotechnology) Semester VI	
Course Title	Large Scale Manufacturing Processes-II	
Course Code	BTH3601	
Credits	2	
	Description	Cognitive level (Bloom's Level)
CO1	Review methods of determination and control various parameters during fermentation and illustrate the role of computers in process control	3,5
CO2	Specify concept of KLa, Scale up and Scale Down	6
CO3	Outline the processes involved in product recovery	3
CO4	Illustrate the downstream process techniques	3
CO5	Elucidate the large-scale manufacturing and recovery processes of fermentation products of various sectors	1, 2
CO6	Outline the concept of Good manufacturing practices (GMP) and Standard Operating practices (SOP) and their relevance. Define and discuss the common terms used in Bioprocess economics	4

Unit - I	**Measurement and Control of different Bioprocess Parameters (Physical and Chemical Parameters):** Temperature, pH, Dissolved oxygen, Microbial biomass, Fluid flow, Pressure, Weight, inlet and exit gas, foam, CO_2, Use of computers in Bioprocess. Concept and Importance of Oxygen Uptake rate, Oxygen transfer rate, KLa Different rheologies of fermentation media Scale Up and Scale down.	10
Unit - II	**Methods and equipment used in Downstream processing:** Definition; Unit operations and downstream processing, General strategy of product recovery; Precipitation (Agents used; Salts, Organic solvents, polyelectrolytes, acids and bases); Filtration (Plate Frame. Rotary Vacuum, Filter Aids, flocculating agents); Centrifugation (types used in Industry; basket, tubular bowl, Scroll, multichamber, disc bowl); Cell Disruption (Physico - mechanical and chemical methods). Liquid- Liquid extraction (Principle, Co and counter current extraction), Distillation, Chromatography (one example each of use of Adsorption, Ion exchange, Gel, Affinity and some recent chromatography techniques) in product recovery can be explained along with manufacturing process of antibiotics, enzymes and vaccines). Membrane Processes (Ultrafiltration, Reverse Osmosis); Drying (Drum and Spray Drying)	10
Unit - III	**Large Scale Manufacturing Process of:** Biomass based Products: Baker's Yeast, Biofertilizers Enzymes: Amylase, any one intracellular enzyme Antibiotics: Penicillins Vitamins: B12, Riboflavin Amino acids: Glutamic acid Vaccines; DPT, Polio Organic Acid: Citric acid Solvents and Beverages: Ethanol and Wine	10

Unit - IV	**Quality Control and Quality Assurance:** Concept of Good Manufacturing Practices (GMP), Standard Operating Practices (SOP) Quality Control and Quality Assurance (Definition, Functions and Responsibilities) Tests Used for Quality Assurance of finished product; Sterility Testing, Pyrogen testing, Bacterial endotoxin (LAL test), Ames Test.	4
Unit - V	**Bioprocess Economics**: Basic objectives in developing economically viable process, Market Potential, Fixed and Variable costs, Depreciation, Amortization, and Selection of Pricing.	2

References:

1. Casida, L. E., Industrial Microbiology. 2nd ed. New Delhi: Newage International, 2019.
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3. Peppler, H. J., D. Perlman. Microbial Technology, Vol I and II, 2nd ed. New York: Academic Press,1979
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6. Crueger, W. and Crueger, A. A Text Book of Industrial Biotechnology. New Delhi, Panima, 2005
7. Patel, A. H. Industrial Microbiology. 2nd ed. Macmillan India Ltd., 2011.

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- http://www.davidmoore.org.uk/21st_Century_Guidebook_to_Fungi_PLATINUM/Ch17_15.htm
- http://www.uop.edu.pk/ocontents/Lec%20no%203.pdf
- https://www.researchgate.net/publication/292400975_Dietary_supplements_based_on_the_yeast_biomass
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2950629/
- https://gravitywinehouse.com/blog/wine-production-bottling-quality-control-plan/
- https://chemeng.queensu.ca/courses/CHEE332/files/distillation.pdf
- https://kta.com/kta-university/quality-assurance-quality-control-roles/
- https://pharmaguidances.com/responsibilities-of-quality-assurance-department/
- https://microbialcellfactories.biomedcentral.com/articles/10.1186/s12934-017-0631-y

BTH3602: Plant Tissue Culture

Programme	T.Y. B.Sc. (Biotechnology) Semester VI	
Course Title	Plant Tissue Culture	
Course Code	BTH3602	
Credits	2	
	Description	Cognitive level (Bloom's Level)
CO1	Recall basic concepts of cell theory, Unique properties of plant cells like Totipotency, Differentiation, Dedifferentiation.	1
CO2	Compare in vivo and in vitro growth of plants. Describe Infrastructural requirements and basic facilities necessary in PTC laboratory. Discuss nutritional requirements of plants, various methods to maintain aseptic conditions.	2
CO3	Demonstrate media preparation, selection and sterilization of explants.	3
CO4	Identify the role of plant growth regulators, different techniques of PTC for various applications.	4
CO5	Standardise different parameters to maintain cultures.	5
CO6	Compose standardised protocol for particular technique using a specific plant. Extrapolate the basic technique of Plant Tissue Culture for various applications.	2,6

Unit -I	**Need for plant tissue culture:** Concepts of Cell theory & Cellular totipotency	1
Unit -II	**PTC Laboratory:** Organization of facility and equipment. Aseptic manipulation – washing, capping, packing and sterilization. Culture media- nutritional requirements of the explants, PGRs and their *in vitro* role.	7
Unit -III	**Micropropagation-** 'Explant' for plant tissue culture. Response of explants *in vitro*– Dedifferentiation and Redifferentiation. Microprapagation- Advantages over conventional methods. Stages of Micropropagation (stage 0 to stage 4); Callus formation. Organogenesis (direct and indirect). Somatic Embryogenesis (direct and indirect) Axillary bud proliferation	6
Unit -IV	**Callus culture technique:** Introduction, principle, factors affecting, Morphology & internal structure; applications and limitations	3
Unit -V	**Suspension culture technique:** Introduction, principle, types, synchronization; applications and limitations	3
Unit -VI	**Organ culture technique:** Introduction, principle, root tip culture, leaf culture, shoot tip & meristem culture. Anther & pollen culture – Introduction, principle, factors affecting. Ovary, ovule, embryo and endosperm culture; Applications and limitations.	7

Unit -VII	**Protoplast:** Isolation, culture and fusion, Somatic hybridization and cybridization, applications and limitations	5
Unit -VIII	**Somaclonal variation:** Introduction, terminology, origin, methods to understand and identify somaclonal variation	2
Unit -IX	Parameters to assess growth and development *in vitro* Applications of plant tissue culture	2

References:

1. M. K. Razdan. *Introduction to Plant Tissue Culture*. 2nd ed. New Delhi, India: Oxford & IBH Publishing Co., 2007
2. S. S. Bhojwani, and M.K. Razdan. *Plant Tissue Culture: Theory & Practice*. New Delhi, India Elsevier
3. T.B. Jha, and B. Ghosh. *Plant Tissue Culture- Basic and Applications*. Hydearbad, India: University Press; 2007
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7. S. Narayanaswamy. *Plant Cell and Tissue Culture*. New Delhi, India: Tata McGraw-Hill Publishing Company Limited., 2004

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- Sant Saran Bhojwani, Prem Kumar Dantu. *Plant tissue culture : An introductory text*
- New Delhi, India, Springer, 2013
- Karl-Hermann Neumann, Ashwani Kumar & Jafargholi Imani. *Plant Cell and Tissue Culture - A Tool in Biotechnology: Basics and Application* ,Verlag Berlin Heidelberg, Springer,2009
- S.S. Bhojwani and M.K. Razdan. Plant Tissue Culture: Theory and Practice, a Revised Edition North Holland, Elsevier., 1996
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- Clive Koelling. *New frontiers in plants in in vitro culture*. New York, USA, Published by Academic Pages
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BTH3603: Techniques and applications in Genetic Engineering

Programme	T.Y. B.Sc. (Biotechnology) Semester VI	
Course Title	Techniques and applications in Genetic Engineering	
Course Code	BTH3603	
Credits	2	
	Description	Cognitive level (Bloom's Level)
CO1	Describe basic techniques of cloning from DNA and RNA, making clone libraries and gene expression	1
CO2	Discuss various strategies for clone selection and screening using PCR and blotting based methods	2
CO3	Examine DNA sequencing methods employed for genetic analysis	3
CO4	Analyse various applications of genetic engineering from transgenic plants to healthcare and therapeutics	4
CO5	Review key concepts in mutagenesis and transgene insertion and expression, determine the advantages and limitations of transgene technology	5
CO6	Integrate genetic engineering tools and knowhow to produce transgenic animals and for gene therapy	6

Unit -I	**Techniques in Genetic Engineering:** Cloning Strategies: Understanding basic principle of Cloning from genomic DNA; Making genomic libraries. Amplification and expression of cloned DNA molecules. Cloning from RNA; Site directed mutagenesis with examples	10
Unit -II	**Selection, screening, and analysis of recombinants:** Genetic selection and screening methods; by chromogenic substrates, insertional inactivation, complementation. Screening using nucleic acid hybridization. Nucleic acid probes, screening clone banks. PCR in screening protocols. Restriction mapping, Blotting techniques	10
Unit -III	**DNA Sequencing:** Principles of DNA sequencing; Preparation of DNA fragments, Maxam - Gilbert (chemical) sequencing; Sanger - Coulson (dideoxy or enzymatic) sequencing; Automated DNA sequencing	6
Unit -IV	**Applications of genetic Engineering:** Transgenic animals and plants, Human genome project; Healthcare; Gene therapy; recombinant vaccines and proteins as therapeutics; Forensics	10

References:

- Glick, Bernard R., and Jack J. Pasternak. *Molecular Biotechnology: Principles and Applications of Recombinant DNA*. 3rd ed, ASM Press, 2003.
- Primrose, S. B., et al. *Principles of Gene Manipulation and Genomics*. 7th ed, Blackwell Pub, 2006.
- Sambrook, J., et al. *Molecular Cloning: A Laboratory Manual: Vol. 2*. 2. ed, Cold Spring Harbor, 1989.
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- Https://Nptel.Ac.in/Courses/102/103/102103013/.
- Http://Www.Addgene.Org/Mol-Bio-Reference.

BTH3604: Animal Tissue Culture

Programme	T.Y. B.Sc. (Biotechnology) Semester VI	
Course Title	Animal Tissue Culture	
Course Code	BTH3604	
Credits	2	
	Description	Cognitive level (Bloom's Level)
CO1	Describe the different aspects for successful animal cell culture	1
CO2	Understand the rationale behind different media compositions and techniques used in ATC	2
CO3	Consider different factors that establish a cell line in vitro and describe variations in cell culture	4,1
CO4	Illustrate the problems associated with cryopreservation and outline the different techniques for successful outcome	3
CO5	Assess different methods of cell characterization	5
CO6	Design different methods of cell culture and describe the applications	6,1

Unit-I	**Animal Tissue culture:** Introduction; Comparison with bacterial culture; Maintenance of aseptic conditions. Contamination; type and detection methods. In vivo vs. in vitro growth conditions for cells of multicellular organisms. Overview of concept of monolayer, suspension, histotypic/organotypic, organ culture.	10
Unit-II	**Equipment and infrastructure:** Laboratory design, Instruments and equipment used in ATC Laminar Air Flow, Incubators, Inverted Microscope, specialised tissue culture equipment	3
Unit-III	**Nutrition & Physiology:** Media and rationale behind medium formulation. Balanced salt solutions Advantages and disadvantages of serum. Serum free media	4
Unit-IV	**Primary cell culture:** Source selection, Different methods of establishing primary cell culture. Special reference to fibroblast culture and lymphocyte culture	4
Unit-V	**Cell lines:** Evolution of cell line, Subculture Finite and transformed cell lines, Mammalian and insect cell line growth conditions,	6

Unit-VI	**Characterization of cell lines**: Need for characterization. Methods of Characterization; Karyotyping, biochemical & genetic characterization of cell lines.	2
Unit-VII	**Cell storage and distribution**: a. Cryopreservation b. Cell repositories	3
Unit-VIII	Application of Animal cell cultures.	4

References:

1. R. Ian Freshney. *Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications.* 6th ed. Wiley & Sons, Inc., USA, 2010.
2. Sudha Gangal, *Principles and Practice of Animal Tissue Culture*, 2nd ed. University Press, India, 2010.

eResources:

- https://www.abcam.com/protocols/counting-cells-using-a-haemocytometer
- http://home.sandiego.edu/~josephprovost/Hemocytometer%20Cell%20Counting%20Protocol.pdf
- https://www.sigmaaldrich.com/technical-documents/protocols/biology/cell-quantification.html
- https://www.biologydiscussion.com/essay/animal-tissue-culture-in-india-laboratory-and-facilities/542913
- https://www.vanderbilt.edu/viibre/CellCultureBasicsEU.pdf

BTH3605: Bioanalytical Techniques- II

Programme	T.Y. B.Sc. (Biotechnology) Semester VI	
Course Title	Bioanalytical Techniques-II	
Course Code	BTH3605	
Credits	2	
	Description	Cognitive level (Bloom's Level)
CO1	Describe basic features and components of different spectrometers, biosensors, and imaging devices	1
CO2	State the physicochemical properties and principles used in these techniques Discuss *in silico* analysis of sequencing data	1,2
CO3	Illustrate experimental details of techniques	3
CO4	Compare and contrast the advantages and limitations of these techniques	4
CO5	Analyze and interpret the results	5
CO6	Design a quality assurance scheme in terms of standard operating procedure for maintenance of instruments	6

Unit -I	Spectroscopic techniques: Theory, instrumentation and applications of infra red (IR), electron spin resonance (ESR) and nuclear magnetic resonance (NMR) spectroscopy	12
Unit -II	Mass spectrometry: components of a mass spectrometer, ionization methods (electron impact, chemical ionization, fast atom bombardment, electrospray, laser desorption), Separation of ions (quadrupole, ion trap, magnetic sector, time of flight), Detector (Faraday cup, electron multiplier), applications	12
Unit -III	Introduction to Biosensors and Bionanotechnology: Opportunities and Challenges, applications	8
Unit -IV	Introduction to biological sequence analysis: Computer-based analyses of biomolecular data, particularly nucleic acid and protein sequences.	4

References:

1. Wilson, K., Walker, J.; *Principles and Techniques of Biochemistry and Molecular Biology*, 7th ed, Cambridge University Press, UK, 2010.
2. Boyer, R..; *Modern experimental biochemistry*, 3rd ed, Benjamin Cummings, USA, 2000.
3. Upadhyay, A., Upadhyay, K., Nath, N.; *Biophysical Chemistry (Principles and Techniques)*, 4th ed, Himalaya Publishing House, India, 2016.

e Resources:

- Papazoglou, E, Parthasarathy A., *Bionanotechnology*, 1st ed, Morgan & Claypool, UK, 2007
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4986445

- https://edu.rsc.org/resources/mass-spectrometry
- https://edu.rsc.org/resources/infrared-ir-spectroscopy

BTH3606: Applications in Agriculture and Environmental Biotechnology

Programme	T.Y. B.Sc. (Biotechnology) Semester VI	
Course Title	Applications in Agriculture and Environmental Biotechnology	
Course Code	BTH3606	
Credits	2	
	Description	Cognitive level (Bloom's Level)
CO1	Describe the role of biotechnology in agriculture	1
CO2	Compare important methods and strategies used for developing transgenic crops. Explain the strategies used for designing biotic/abiotic stress resistant crops, crops with enhanced nutrition and for therapeutics. Summarize the concept of gene pyramiding	2,4
CO3	Hypothesize and design new strategies for developing transgenic crops with desired traits	6
CO4	Outline the importance of bioinformatics and the concept of "omics" in biology. Evaluate and justify the need of genomics, proteomics, transcriptomics techniques in research and development	3,5
CO5	Assess the conservation concerns of various taxa currently threatened by anthropogenic activities	5
CO6	Compile information on the various biotechnological interventions in the conservation of biodiversity	6

Unit-I	**Agriculture Biotechnology:** Biotechnology in crop trait improvement, concept of gene pyramiding, transgenic crops for biotic and abiotic stress resistance, genetically modified crops with enhanced nutrition, GM crops for therapeutics	12
Unit-II	**Environmental Biotechnology:** Use of Biotechnology in Environmental Monitoring: Biomarkers, Biosensors, Bioindicators, RS-GIS; Biotechnology in pollution prevention and control, environmental clean-up; Community Sampling Methods.	10
Unit-III	**Biotechnology in Biological Conservation:** Biological Conservation and the necessity to conserve biodiversity; Role of Biotechnology in Biological Conservation – DNA hybridization, DNA barcoding, population genetics; Environmental Impact Assessment process and its case studies	8
Unit-IV	**Biotechnology and Bioinformatics:** Importance of bioinformatics in various fields of biotechnology; concept of "omics" (genomics, proteomics, transcriptomics) and its applications based on recent research	6

References:

1. Slater, Adrian, Nigel Scott, and Mark Fowler. *Plant biotechnology: the genetic manipulation of plants*. , Oxford University Press, 2008.
2. Bahadur Bir, Manchikatla Venkat Rajam, Leela Sahijram, and K. V. Krishnamurthy. *Plant Biology and Biotechnology: Volume II: Plant Genomics and Biotechnology*. New Delhi, India, Springer, 2015.
3. Glick, Bernard R., and Cheryl L. Patten. *Molecular biotechnology: principles and applications of recombinant DNA*. Vol. 34. USA, John Wiley & Sons, 2017.

4. Stewart Jr, C. Neal. *Plant biotechnology and genetics: principles, techniques, and applications*. John Wiley & Sons, 2016.
5. Arivaradarajan, Preeti, and Gauri Misra.*Omics approaches, technologies and applications: integrative approaches for understanding OMICS data*. Singapore, Springer, 2019.
6. Manzoni, Claudia, Demis A. Kia, Jana Vandrovcova, John Hardy, Nicholas W. Wood, Patrick A. Lewis, and Raffaele Ferrari. "Genome, transcriptome and proteome: the rise of omics data and their integration in biomedical sciences." *Briefings in bioinformatics* 19, no. 2 (2018): 286-302.
7. Corlette, Richard. A bigger toolbox: biotechnology in biodiversity conservation. *Trends in Biotechnology* 1411 (2016).

eResources:

- https://www.ebi.ac.uk/training/online/
- https://omicstutorials.com/

BTH 3607: Biotechnology Practical- IV (LSMP II + PTC)

Programme	T.Y. B.Sc. (Biotechnology) Semester VI	
Course Title	Biotechnology Practical-IV (LSMP II + PTC)	
Course Code	BTH3607	
Credits	2	
	Description	Cognitive level (Bloom's Level)
CO1	Perform lab scale production and recovery of a primary and secondary metabolite	6
CO2	Determine / Estimate the amount of primary and secondary metabolite	5
CO3	Demonstrate Sterility check technique for a product. Wine production process and determine its properties	1, 3
CO4	Explain how to prepare stock solutions and media for various culture techniques	2, 4
CO5	Demonstrate Callus culture technique, Suspension culture technique, embryo culture and axillary bud culture technique.	3
CO6	Manipulate Auxin: Cytokinin ratio to regenerate the entire plant.(Micropropagation) Standardise the protocol for specific plant	5

Sr. No.	List of Practicals	Practical (12P)
1.	Production, Recovery and estimation of Primary metabolite (Organic acid and Ethanol)	2
2.	Production, Recovery (Filtration, Solvent extraction) and estimation (Bioassay) a of Secondary metabolite (Antibiotic)	2
3.	Sterility testing of injectables / autoclave	1
4.	Preparation and study of different properties of wine.	1
5.	Visit to a fermentation Industry	
6.	PTC- Stock solutions & media preparation	1
7.	Micropropgation	1
8.	Callus culture technique - Initiation of culture, callus morphology & internal structure	2
9.	Suspension culture technique - Initiation of culture, sub culture and growth measurement	1
10.	Initiation of shoot tip culture / Axillary bud culture / Embryo culture	1

BTH3608: Biotechnology Practical- V
(Techniques in Genetic Engineering +Bioanalytical techniques II)

Programme	T.Y. B.Sc. (Biotechnology) Semester VI	
Course Title	Biotechnology Practical-V (Techniques in Genetic Engineering Bioanalytical techniques II)	
Course Code	BTH3608	
Credits	2	
	Description	Cognitive level (Bloom's Level)
CO1	Discuss the concept of restriction mapping and solved related problems	2
CO2	Plan and prepare an experiment of plasmid DNA digestion and ligation	6
CO3	Describe the process of PCR / DNA fingerprinting and perform the amplification using molecular markers	1
CO4	Illustrate how spectroscopic techniques (IR, ESR, NMR) can be used for structure determination	3
CO5	Review basics of mass spectrometry and discuss its applications	2, 5
CO6	Compare various methods of glucose estimation and explain working of a glucometer	2, 4

Sr. No.	List of Practicals	Practical (12P)
1.	Plasmid DNA digestion	1
2.	Plasmid DNA ligation	2
3.	Restriction mapping	2
4.	PCR amplification/ DNA fingerprinting	2
5.	Demonstration of spectroscopic techniques (IR, ESR, NMR)	2
6.	Demonstration of mass spectrometry	2
7.	Demonstration of working of a glucometer	1

BTH3609: Biotechnology Practical- VI
(ATC + Applications in Agriculture and Environmental Biotechnology)

Programme	T.Y. B.Sc. (Biotechnology) Semester VI	
Course Title	Biotechnology Practical-VI (ATC + Applications in Agriculture and Environmental Biotechnology)	
Course Code	BTH3609	
Credits	2	
	Description	Cognitive level (Bloom's Level)
CO1	Identify the infrastructural requirements for ATC	1
CO2	Interpret the importance of aseptic conditions and transfer the understanding in practice	2
CO3	Demonstrate different cell morphologies and characteristics	3
CO4	Appraise different staining methods and their specific use	5
CO5	Perform different types of cell cultures and understand the rationale behind them	6
CO6	Describe the use of mutagenesis approach to introduce genetic variability in plants. Analyze the effects of mutagenesis on genetic variability in plants	1,4

Sr. No.	List of Practicals	Practical (12P)
1.	ATC laboratory design and equipment used in ATC	1
2.	Aseptic conditions	1
3.	Animal cell culture media preparation, sterilization, washing, packing	2
4.	Observation of cells in culture - Principles & practice	1
5.	Isolation of Lymphocyte for culture; Ficoll-hypaque density gradient separation	2
6.	Cell staining methods viz. Giemsa	1
7.	Maintenance of cell lines	2
8.	Viable cell count and growth studies	1
9.	Visit to cell culture facility / Production set up/ Field Visit for community sampling	1
10.	Non targeted mutagenesis for inducing phenotypic variability in plants and analyzing the effects of mutagenesis	2

References:

1. R. Ian Freshney. *Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications.* 6th ed. Wiley & Sons, Inc., USA, 2010.
2. Sudha Gangal, *Principles and Practice of Animal Tissue Culture,* 2nd ed. University Press, India,2010.

eResources:

- https://www.abcam.com/protocols/counting-cells-using-a-haemocytometer
- http://home.sandiego.edu/~josephprovost/Hemocytometer%20Cell%20Counting%20Protocol.pdf
- https://www.sigmaaldrich.com/technical-documents/protocols/biology/cell-quantification.html

- https://www.biologydiscussion.com/essay/animal-tissue-culture-in-india-laboratory-and-facilities/542913
- https://www.vanderbilt.edu/viibre/CellCultureBasicsEU.pdf

BTH 3611: Introduction to Bioinformatics

Programme	T.Y. B.Sc. (Biotechnology) Semester VI	
Course Title	Introduction to Bioinformatics	
Course Code	BTH3611	
Credits	2	
	Description	Cognitive level (Bloom's Level)
CO1	Describe various bioinformatics tools and technique	1
CO2	Explain the structure and data storage formats in the biological databases and flow of biological information	2
CO3	Discuss various methods for the data retrieval, data storage, and data mining and use that data for the further analysis.	3
CO4	Use various sequence alignment tools and compare the unknown sequence with known sequence	6
CO5	Analyse the biological experimental data using bioinformatics tools.	5
CO6	Analysis of Multiple sequences by using various MSA tools and evaluate the level of homology	4

Unit-I	Bioinformatics- Introduction and definition, History and Scope, Applications of Bioinformatics in various fields.	2
Unit-II	**Nucleic Acid Sequence Databases:** Nucleic acid sequence databases: (GenBank, EMBL, DDBJ), Keyword-based search at Entrez Search Engine at NCBI. Sequence Submission tools at NCBI, EMBL etc. Protein sequence database: UniProtKB (SwissPort, TrEMBL). **Practical's based on the above databases**. **Open Access Bibliographic Resources and Literature Databases:** PubMed, MEDLINE, PubMed Central at NCBI **Exploring the *in silico* tools for primer designing** **Practical's based on the above databases.**	12
Unit-III	**Sequence Analysis:** Various File Formats for Bimolecular Sequences: GenBank, FASTA **Basic concepts of sequence analysis:** Global Pairwise Sequence Alignment, Local Pairwise Sequence Alignment Needleman and Wunsch, Smith and Waterman algorithms for pairwise alignments, gap penalties, use of pairwise alignments for analysis of Nucleic acid and Protein sequences and interpretation of results. **Databases Searches**: BLAST, FASTA Scoring matrices: Basic concept of a scoring matrix, Matrices for nucleic acid and proteins sequences, PAM and BLOSSUM series. **Practical's based on the above tools**	10

Unit-IV	**Multiple Sequence Alignment:** The need for MSA, Basic concepts of various approaches for MSA (e.g. progressive, hierarchical, iterative etc.). **Concept of Phylogeny**: Molecular Phylogeny, Various Methods of Phylogenetic Tree Construction **Practical's based on the above tools**	6

References:

1. David W. Mount, *Bioinformatics Sequence and Genome Analysis* 2nd ed. cold spring harbor New York, USA: Cold spring harbor laboratory press, 2004
2. Jin Xiong, *Essential Bioinformatics* 1st ed. United States of America by Cambridge University Press, New York, 2006
3. AH wood, T.K. Parry smith DJ, *Introduction to bioinformatics*, Pearson education Asia, 2001
4. AD Baxevanis & BFF Ouellette, *Bioinformatics: A practical guide to the analysis of genes and proteins*, Wiley Interscience New York, 2001.
5. Stephen Misener & Stephen A. Krawetz, *Bioinformatics: Methods and Protocols*, Humana Press, New Jersey, 2000
6. Des Higgins &Willie Taylor, *Bioinformatics: Sequence, structure and databanks*, Oxford University Press, 2000

e Resources:

- https://www.edx.org/learn/bioinformatics
- https://www.coursera.org/specializations/bioinformatics
- https://www.ebi.ac.uk/
- https://www.expasy.org/
- https://www.rcsb.org
- https://www.uniprot.org/

BTH3612: Soil analysis

Programme	T.Y. B.Sc. (Biotechnology) Semester VI	
Course Title	Soil analysis	
Course Code	BTH3612	
Credits	2	
	Description	Cognitive level (Bloom's Level)
CO1	Define soil, describe its properties, state the factors that decide soil fertility	1
CO2	Discuss objectives of soil testing and requirements for setting up a soil testing laboratory	2
CO3	Apply basic analytical methods to evaluate physico-chemical properties of soil	3,5
CO4	Perform microbiological analysis of soil	6
CO5	Analyze the soil type based on results of various tests	4
CO6	Discuss the importance and limitations of mobile soil testing laboratory	2

Unit-I	Introduction: definition of soil, major soil types of India, its composition, physical, chemical and biological properties of soil, fertility of soil, properties which decide soil fertility (colour, depth, bulk density, field capacity, acidity, alkalinity, cation exchange capacity, organic matter, nitrogen cycle)	6
Unit-II	Soil testing: historical background, soil nutrient as an index of soil fertility, objectives of soil testing, balanced fertilization, basic requirements for setting up a soil testing laboratory, laboratory safety measures, quality control, sampling, preparation of samples for analysis,	6
Unit-III	Soil analysis (Practical): analytical methods for studying physicochemical properties (texture, structure, moisture content, water holding capacity, pH, lime requirement, electrical conductivity, gypsum requirement, organic carbon, total nitrogen, available phosphorous), microbiological methods (checking presence of microbes in given soil sample, counting their approximate number, growth of *Azotobacter*/*Aspergillus niger*)	20
Unit-IV	Mobile soil testing laboratory (Van): aim, objectives and field operation	4

References:

1. Benton, J.; *Soil analysis handbook of reference methods*, 1st ed, CRC Press, 1999.
2. Pal, S.; *Textbook of soil science*, 1st ed, Oxford and IBH publishers, 2019.

e Resources:

- https://agriculture.uk.gov.in
- Kolay, A.; *Soil fertility*, 1st ed, Atlantic publishers, 2018 (Ebook)

BTH3613: Survey Methodology

Programme	T.Y. B.Sc. (Biotechnology) Semester VI	
Course Title	Survey Methodology	
Course Code	BTH3613	
Credits	2	
	Description	Cognitive level (Bloom's Level)
CO1	Describe basic types of survey methods	1
CO2	Discuss aspects of survey design and modes of data collection	2
CO3	Examine various errors in surveys	3
CO4	Analyze data and present results	4
CO5	Review ongoing surveys and the ethical and legal issues of data collection	5
CO6	Interpret survey data and review outcome	6

Unit-I	**Introduction to Survey Methodology:** Purpose of surveys Types of surveys (with examples of ongoing surveys) Overview of survey methodology Ethical and legal issues	2
Unit-II	**Survey Design:** Lifecycle of a survey Questionnaire design Study variables Sampling and population coverage Modes of data collection	7
Unit-III	**Errors in surveys and Non-response:** Measurement and processing errors Coverage error Sampling errors Interviewer-bias Non-response errors	5
Unit-IV	**Survey Data Analysis and Presentation:** Interpreting survey findings Methods of data analysis Presentation of results and outcome	10
Unit-V	**Designing, conducting, analysing and presenting a survey**	12

References:

1. Groves, Robert M., editor. *Survey Methodology*. 2nd ed, Wiley, 2009.

2. Belson, William A. Validity in Survey Research: With Special Reference to the Techniques of Intensive Interviewing and Progressive Modification for Testing and Constructing Difficult or Sensitive Measures for Use in Survey Research: A Report. Gower, 1986.
3. Fowler, Floyd J. Improving Survey Questions: Design and Evaluation. Sage Publications, 1995.
4. Levy, Paul S., and Stanley Lemeshow. Sampling of Populations: Methods and Applications. 4th ed, Wiley, 2008.
5. Metwally, Elham. "Survey Research Methods20121Earl R. Babbie.Survey Research Methods. Belmont, CA: Wadsworth, Inc 1990." Journal of Organizational Change Management, vol. 25, no. 1, Feb. 2012, pp. 186–88.
6. Salant, Priscilla, and Don A. Dillman. How to Conduct Your Own Survey.Wiley, 1994.
7. "The Survey Research Handbook. "Technometrics, vol. 41, no. 1, Feb. 1999, pp. 83–84.

eResources:

- https://www.mitre.org/sites/default/files/pdf/05_0638.pdf

BTH3614: Research proposal writing and presentation

Programme	T.Y. B.Sc. (Biotechnology) Semester VI	
Course Title	Research proposal writing and presentation	
Course Code	BTH3614	
Credits	2	
	Description	Cognitive level (Bloom's Level)
CO1	Explain the importance of a good research proposal	2
CO2	Order and arrange the research proposal in its standard format	4
CO3	Illustrate features of a good research proposal	3
CO4	Outline the basics and requirements for acquiring a start-up grant	1
CO5	Determine and justify the ethics of scientific writing and anti-plagiarism	5
CO6	Design and develop a project proposal for applying for a start-up grant	6

Unit-I	Introduction: importance of a research proposal, why writing a good research proposal is a challenging task, what are the basic requirements of a research proposal	2
Unit-II	Main contents of a research proposal: introduction, literature review, aims and objectives, experimental design and methods, budget, ethical considerations, and references	3
Unit-III	What is a good research proposal? Highlights and features significance	2
Unit-IV	Examples of research proposals	3
Unit-V	Workshop on research proposal writing	8
Unit-VI	**Applying for start-up funding-** basics, requirements, opportunities (exploring start-up research grants), helpful tools and resources, strategies for developing a proposal, drafting the objectives and preparing the budget	10
Unit-VII	**Preparation of project proposal and project presentation** - detailed discussion, student activity	6
Unit-VIII	**Ethics of scientific grant writing**, importance and process of plagiarism check, research ethics and code of conduct	4

References:

1. Denicolo, P., Becker, L., *Developing research proposals*, 1st ed, SAGE publications, USA, 2012
2. Peters, A., *Winning research funding*, 1st ed, Taylor and Francis, USA, 2019
3. Henson, Kenneth T. *Successful Grant Writing for School Leaders: 10 Easy Steps*. Pearson Higher Ed, 2011.
4. New, Cheryl Carter, and James Aaron Quick. *How to write a grant proposal*. Vol. 217. John Wiley & Sons, 2003.
5. Sohn, Emily. Secrets to writing a winning grant. *Nature* 577.7788 (2020): 133-135.

e Resources:

- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5037942
- https://www.birac.nic.in/big.php
- https://www.growthink.com/capital-raising/grants/how-to-write-small-business-grant-proposal
- https://www.who.int/about/ethics/code-of-conduct-for-responsible-research#:~:text=The%20Code%20of%20Conduct%20for,professional%20commitment%20described%20in%20WHO's
- https://dst.gov.in/
- http://dbtindia.gov.in/
- http://www.serb.gov.in/home.php